J. Raptor Res. 31(4):358–363

TEMPORAL, CLIMATIC AND LUNAR FACTORS AFFECTING OWL VOCALIZATIONS OF WESTERN WYOMING

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Abstract.—We evaluated the effect of season, time after sunset, lunar phase, cloud cover and temperature on the vocalizations of Long-eared (*Asio otus*), Boreal (*Aegolius funereus*) and Northern Saw-whet (*A. acadicus*) Owls in northwestern Wyoming. All three owl species were most vocal in March and April. Boreal Owls were more vocal in the first hr after sunset while Long-eared and Northern Saw-whet Owls vocalized most during the first two hr after sunset. Northern Saw-whet Owls sang more than expected during half to full moons and under 50–75% cloud cover. Only Northern Saw-whet Owls responded to temperature, singing less than expected below −5°C.

Key Words: *Long-eared Owl;* Asio otus; *Boreal Owl;* Aegolius funereus; *Northern Saw-whet Owl;* Aegolius acadicus; *owl vocalization; Wyoming.*

Temporal, Climatico y Factores de Lunar afectando vocalizaciones del buho en el oeste de Wyoming

Resumen.—Nosotros evaluamos el efecto de tiempo, tiempo despues del puesta del sol, etapa lunar, nublado y temperatura en la vocalizacion de *Asio otus, Aegolius funereus* y *A. acadicus* en el oeste del norte en Wyoming. Todo los tres especie de búho fueron mas vocales en marzo y abril. *Aegolius funereus* fueron mas vocales en la primer hora despues que la puesta de sol mientras *Asio otus* y *A. acadicus* vocalizaron mas durante las primer dos horas despues que la puesta de sol. *A. acadicus* canto mas que esperado durante lunas llenas y de mitad y abajo de 50–75% cubierto de nubes. Solo *A. acadicus* respondio a temperatura, cantando menos que esperado en menos de −5°C.

[Traducción de Raúl De La Garza, Jr.]

Vocalizations are used widely to locate and identify various species of owls. Their taped songs are played along routes or specific locations in late winter-early spring when many owls are territorial and vocalize to attract mates. There are many factors that may influence owl vocalizations. For instance, both physiological and environmental influences have been found to contribute to the seasonal or daily timing of courtship behavior and the frequency of avian vocalizations (Armstrong 1963, Welty and Baptista 1988). Temperature extremes also act as a secondary means of timing seasonal breeding activity by either advancing or delaying it (Armstrong 1963, Best 1981, Welty and Baptista 1988). In owls, high winds and heavy precipitation are known to deter owl vocalizing (Johnson et al. 1981, Palmer 1987, Smith 1987, Morrell et al. 1991). In addition, interspecific competition, intraspecific vocalization frequencies, prey densities and even lunar cycles can directly or indirectly affect owl calling and breeding activity (Robbins 1981, Hayward and Garton 1988, Hejl and Beedy 1986, Palmer 1987).

Since vocalizations are used in the estimation of owl populations, it is important that environmental variables affecting owl calling be identified. Surveys made during periods or conditions when owl vocalizing is suppressed may lead to erroneous population or species counts. We designed this study to identify the effects of season, time after sunset, lunar phase, cloud cover and temperature on the vocalizations of Long-eared (*Asio otus*), Boreal (*Aegolius funereus*), and Northern Saw-whet (*A. acadicus*) Owls.

Study Area

The study took place in western Wyoming, 56 km south of Jackson. It encompassed approximately 113 700 ha (1137 km^2) of the Grey's River Ranger District, Bridger-Teton National Forest. Mean annual temperature for areas above 2100 m is

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−20°C with the coldest months of the year being December and January (USFS 1990). Typically, only a 2-wk-period during the year is frost-free (June or early July). Total average precipitation is 1.5 m (USFS 1990) and the majority of this falls as snow (>66%), with the highest snowfall during December. Maximum snow accumulation occurs in April, ranging from approximately 1–3 m in depth (USFS 1990). Most summer precipitation occurs through intense thunderstorms (>5 cm/hr of rain). Elevational changes are extreme. The river valley occurs at approximately 1768 m and the tallest peaks reach approximately 3350 m.

The Grey's River drainage represents a vegetative transition zone between the plant communities of the Great Basin and the Southern Rocky Mountain Regions (USFS 1990). Approximately 30% of the area consists of meadow and lowland, riparian shrub or upland shrub vegetation. In the lowland riparian shrub communities, willows (*Salix* spp.) dominate the habitat, whereas in the upland shrub communities, mountain big sagebrush (*Artemisia tridentata*) dominates (Steele et al. 1983).

Most common tree species are lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmanni*), subalpine fir (*Abies lasiocarpa*) and Douglas-fir (*Pseudotsuga menziesii*). They represent approximately 40%, 20% and 2% of the study area's respective habitat types (USFS 1990). Dominant stands of Engelmann spruce exist sporadically along stream terraces, benches or seeps (Steele et al. 1983).

Hardwood stands represent only a small portion of the area (about 5%). These usually consist of small stands of quaking aspen (*Populus tremuloides*) that occur on upland mesic sites. A small amount of mature narrowleaf cottonwood (*Populus angustifolia*) stands are scattered along the floodplains.

METHODS

We developed a network of 26 transects for the Grey's River study area (18 in 1992 and eight in 1993), which encompassed an elevational gradient between 1760–2700 m. Based on a preliminary overview of the area, we placed transects randomly in accessible areas with low avalanche potential. We chose areas accessible in each habitat type from the total available by means of stratified sampling. Because the study had a high degree of patchiness, we could not contain transects within homogenous habitat segments. The distance between transects varied, but no transect was closer than 1 km, and most were >5 km apart.

Transect length varied from 3–10 km (134 km total). Transect width was also variable. Any vocalizing owl that could be identified and located was considered to be within the sample area. During the initial phase of the study, we determined the distance we could hear owl and taped calls. As a result, we established a separate survey protocol for each transect.

We only collected data on calm nights with little wind (<10 km/hr) or precipitation in 1992 and 1993. We did not conduct surveys on windy, wet nights because we had difficulty getting to transect locations. The literature also indicates high winds and heavy precipitation inhibit owl vocalizations (Springer 1978, Johnson et al. 1981, Smith and McKay 1984, Palmer 1987, Smith 1987, Morrell et al 1991). From 1 March–1 June, we recorded vocalizations by snowmobile, ATVs, snowshoes and skis. This sampling period corresponded with the early courtship and most vocal period for most owls in the area. We surveyed each transect three times during a field season from sunset to sunrise. In 1992, we surveyed each transect at least once during a half waxing to full moon phase, a new moon phase and a quarter moon phase.

Along each transect, we stationed observers at 250 m intervals at alternating calling and listening stations. Calling stations were 500 m apart, as were listening stations, but the distance between the two stations was 250 m. At calling stations, one observer played a series of recorded owl vocalizations, using a portable cassette recorder equipped with an amplified speaker system, while listening and looking for owls. At listening stations, observers looked and listened for owls while the tape was being played at the adjacent calling station. Using this technique, we were able to sample a greater area and better identify distant owls that could not be heard by only one observer. In addition, we could more easily determine owl locations when two people simultaneously "triangulated" upon the same owl location.

Vocalizations of all three owl species were played starting with the smallest species first, and ending with the largest species. We chose this method to antagonize any owls present in the immediate vicinity, without intimidating the smaller owls by playing the largest owl vocalization first. At each calling station, 45 sec of primary vocalizations was followed by 90 sec of listening. We felt that we could get the best response if each species' vocalization was played twice before progressing to the vocalization of the next species. When an owl responded, we recorded both the species and its location. We recorded only the location of the initial response to prevent double sampling of individuals that may have followed us along the sampling transect. If an owl was already vocalizing, we recorded its location without playing the tape. Thus, our results use both birds that were calling and responding to taped vocalizations.

We used a Chi-square goodness-of-fit test to determine if season, time of night, temperature, cloud cover or lunar phase affected owl vocalizations. If a variable was significant, we used a 95% Bonferroni confidence interval to determine significant categories (Neu et al. 1974, Byers and Steinhorst 1984).

RESULTS

All three species of owls showed noticeable seasonal trends in their vocal activity but all three were most vocal from March–April in both years.

Table 1. Percent of Long-eared (LEOW), Boreal (BOOW), and Northern Saw-whet (SWOW) Owl vocalizations recorded by sampling periods and hours after sunset in the Grey's River drainage of western Wyoming.

		LEOW	BOOW	SWOW
Sampling Periods				
01–15 Mar.	1992	31	19	27
	1993	60	37	11
16–31 Mar.	1992	06	32	10
	1993	30	11	32
01–15 Apr.	1992	38	13	31
	1993	—	38	28
16–30 Apr.	1992	—	24	10
	1993	—	14	11
01–15 May	1992	12	06	07
	1993	10	—	18
16–31 May	1992	13	06	15
	1993	—	—	—
Hours after Sunset				
0–1	1992	38	53	21
	1993	23	44	22
1–2	1992	23	07	25
	1993	33	20	35
2–3	1992	23	20	24
	1993	18	06	23
3–4	1992	08	20	16
	1993	25	24	16
4–5	1992	08	—	14
	1993	—	06	04

Sample size: LEOW 1992 = 13, 1993 = 12; BOOW 1992 = 15, 1993 = 16; SWOW 1992 = 162, 1993 = 28.

Most (75%) of the Long-eared Owl vocalizations were recorded from 1 March–15 April (Table 1). In 1992, 31% of these were in early March and there was a second peak in early April when an additional 38% of the vocalizations were recorded (38%). In 1993, 60% of all Long-eared Owl vocalizations occurred during a 2-wk-period from 1 March–15 March. An additional 30% was heard from 16 March–31 March. Overall, 90% of the vocalizations in 1993 were heard before 1 April (Table 1).

Seasonal Boreal Owl patterns of vocalizations were similar both in 1992 and 1993 (Table 1). Peak periods occurred in March and April, during which time >80% of all Boreal Owl vocalizations were recorded. Boreal Owl song activity declined in May in both years. We found a difference in seasonal song patterns in each year of our study. In 1992, more vocalizations were heard in late March and late April (32% and 24%, respectively). In 1993, these biweekly peaks occurred in early March (37%) and early April (38%).

There were also annual differences in the vocalization patterns of Northern Saw-whet Owls (Table 1). In 1992, saw-whets displayed a biweekly peak with peaks occurring in both the first half of March (27%) and the first half of April (31%). In 1993, we heard more saw-whets after 15 March, which was consistent until 15 April. During the last half of March and the first half of April, we heard over half of all saw-whet vocalizations (32 and 28%, respectively). Even with annual differences, a seasonal saw-whet vocalization pattern developed with over 70% of the vocalizations occurring from 1 March–15 April in both years.

Long-eared Owl vocalizing peaked within the first 2 hr after sunset (Table 1). Annual differences were evident. In 1992, 38% of nightly long-eared vocalizations occurred within 1 hr of sunset. This peak was followed by a gradual decrease throughout the remainder of the night. In 1993, no hourly trend was obvious. Over half of the long-eared vocalizations occurred within the first 2 hr after sunset but they continued for at least 4 hr following sunset.

In both years, Boreal Owls appeared to be the most vocal within the first hour after sunset (Table 1). This was followed by a decline between 1–2 hr after sunset with a slight increase until 4 hr after sunset when vocalizations decreased again.

We heard more Long-eared and Northern Saw-whet Owls within the first few hours of sunset. Saw-whets increased their singing from sunset to a peak 1–2 hr postsunset (Table 1). After 2 hr, saw-whet singing decreased gradually throughout the night. Annual differences were not apparent for saw-whet nightly song patterns.

We found that Northern Saw-whet Owls showed differences in vocal activity in relation to the phase of the moon (Table 2). Saw-whets vocalized more than expected during a waxing half to full moon phase. Boreal and Long-eared Owls did not appear to respond to lunar changes.

Cloud cover did affect Northern Saw-whet Owl vocalizations (Table 3). Bonferroni 95% CI indicated that saw-whets were more vocal with 50–75% cloud cover but cloud cover did not significantly affect Long-eared or Boreal Owl vocalizations.

The Northern Saw-whet Owl was the only species we found to be affected by ambient temperature

Table 2. Chi-square *P*-values for observed versus expected vocalizations of Long-eared (LEOW), Boreal (BOOW) and Northern Saw-whet (SWOW) Owls in relation to lunar phase in the Grey's River drainage in western Wyoming Comparison made with Bonferroni 95% confidence intervals (Byers and Steinhorst 1984).

SPECIES	CHI SQUARE P-VALUE	CATEGORY[a]	OBSERVED SINGING	95% CONFIDENCE INTERVAL	EXPECTED SINGING
LEOW	0.213				
BOOW	0.706				
SWOW	0.003	1	0.1695	0.0869–0.2521	0.1704
		2	0.3955	0.2879–0.5031	0.2817*
		3	0.1017	0.0352–0.1682	0.1722*
		4	0.3333	0.2295–0.4371	0.3756

[a] 1 = one day after a new moon through ½ waxing; 2 = one day after a ½ waxing through full moon; 3 = one day after a full moon through ½ waning; 4 = one day after ½ waning through new moon. * = significant at alpha = 0.05.

(Table 4). It vocalized less than expected below −5°C.

DISCUSSION

Our results showed that Long-eared, Boreal and Northern Saw-whet Owls change the patterns of their vocalizations during the breeding season but only the vocalizations of the Northern Saw-whet Owl are affected by phase of the moon, temperature and cloud cover.

The majority of male long-ear vocalizations occurred from early March to mid-April. In Idaho, long-ears nest from mid-April to early May and approximately 1–2 wk after egg laying, males decrease their vocalizing (Craig and Trost 1979, Johnsgard 1988, Voronetsky 1987). Based on this, we concluded that long-ears started nesting in our study area in early April.

Boreal Owls should show a peak in calling activity at 40°N latitude when the photoperiod consists of 14 hr of darkness (Palmer 1987, Bondrup-Nielsen 1984). In studies conducted in northern Colorado and eastern Idaho, boreal calling intensity increased in March and peaked during April (Hayward and Hayward 1989, Palmer 1987). Our results were very similar with the peak in calling activity occurring from March–April. This suggested that the majority of Boreal Owls nested by early May in the Grey's River study site.

We observed an annual variation in Northern Saw-whet Owl calling. This may have been related to changes in prey densities (Palmer 1987, Jones 1991). Due to the decreased chance of successful nesting, many resident owls may not vocalize when prey populations were low (Palmer 1987, Jones 1991). In addition, latitudinal and elevational migrations in the Rocky Mountain region (Johnsgard 1988) may cause decreases in prey populations.

In 1992, we heard 177 Northern Saw-whet Owl vocalizations compared to only 28 in 1993. Sampling effort (less in 1993) and the type of habitat sampled (more coniferous in 1993) were different

Table 3. Chi-square *P*-values for observed and expected vocalizations of Long-eared (LEOW), Boreal (BOOW) and Northern Saw-whet (SWOW) Owls in relation to cloud cover in the Grey's River drainage of western Wyoming. Comparison made with Bonferroni 95% confidence intervals (Byers and Steinhorst 1984).

SPECIES	CHI SQUARE P-VALUE	CATEGORY[a]	OBSERVED SINGING	95% CONFIDENCE INTERVAL	EXPECTED SINGING
LEOW	0.627				
BOOW	0.531				
SWOW	0.005	1	0.5714	0.4830–0.6598	0.6061
		2	0.1735	0.1059–0.2411	0.1873
		3	0.1837	0.1146–0.2529	0.1068*
		4	0.0714	0.0254–0.1174	0.0998

[a] 1 = 0–24% cloud cover; 2 = 25–49% cloud cover; 3 = 50–74% cloud cover; 4 = 75–100% cloud cover. * = significant at alpha = 0.05.

Table 4. Chi-square *P*-values for observed and expected vocalizations of Long-eared (LEOW), Boreal (BOOW) and Northern Saw-whet (SWOW) Owls in relation to ambient temperature in the Grey's River drainage of western Wyoming. Comparison made with Bonferroni 95% confidence intervals (Byers and Steinhorst 1984).

SPECIES	CHI SQUARE *P*-VALUE	CATEGORY[a]	OBSERVED SINGING	95% CONFIDENCE INTERVAL	EXPECTED SINGING
LEOW	0.941				
BOOW	0.163				
SWOW	0.018	1	0.0	none	0.0235*
		2	0.4859	0.3920–0.5798	0.3942
		3	0.4068	0.3145–0.4991	0.4376
		4	0.1073	0.0491–0.1654	0.1447

[a] 1 = <−6°C; 2 = −5°C to 0°C; 3 = 1°C to 5°C; 4 = >6°C. * = significant at alpha = 0.05.

between the two years. These factors were likely to have contributed to the differences observed between years.

Decreasing light intensity is the most important factor for stimulating the initiation of nightly owl calling (Armstrong 1963). Most owl species exhibit a biphasic nightly calling pattern. Peak calling intensity usually occurs within 2–3 hr after sunset, followed by another predawn increase (Johnson et al. 1981, Smith 1987, Hayward and Garton 1988). We had difficulty comparing our results with others. Standardization is needed in reporting nightly calling activity for owls. Much of the literature has reported nightly vocalizations by time. Photoperiod increased approximately 1–2 min/day during the late winter/spring at our study site. This could have a marked effect in northern temperate regions. Over long seasonal sampling periods, the differences in photoperiod would be considerable with daylight increasing as much as 90 min over a 90-d period.

Moonlight changed light intensity and could have affected owl calling. Owls including Great Horned Owls (*Bubo virginianus*) Boreal Owls (*Otus kennicotti*), Northern Saw-whet Owls and Western Screech-owls are stimulated to vocalize by moonlight, especially a bright waxing to full moon cycle (Johnson et al. 1981, Palmer 1987, Morrell et al. 1991). Our results did not support this and showed that only saw-whets called more than expected during a waxing half to full moon phase. Boreal Owl seasonal patterns showed biweekly peaks which coincided with a full moon phase.

Similarly, our results were not consistent with those of Palmer (1987) in terms of the affect of cloud cover and temperature on the vocalizations of these three owls. Unlike Palmer, who reported an increase in vocalizations on clear nights in Boreal and Northern Saw-whet Owls, we found only vocalizations of the Northern Saw-whet Owl to increase during 50–75% cloud cover. Palmer did not find any significant results regarding temperature and calling activity for Boreal and Northern Saw-whet Owls. He did note, however, that most Boreal Owls vocalized over temperatures ranging from −10°C to 5°C, and most saw-whets vocalized between −5°C and 0°C. Our study showed that extremely low temperatures inhibited Northern Saw-whet Owl calling with vocalizations occurring less than expected when temperatures were <5°C. Nevertheless, our small sample size may have impacted our results and caused the Chi-square statistic to be a more liberal estimate (Roscoe and Byars 1971, Neu et al. 1974).

ACKNOWLEDGMENTS

We greatly appreciate the assistance of D. Crowe, S. Breck, J. Bigelow and N. Moody with our fieldwork. Both the Wyoming Game and Fish Department and Bridger-Teton National Forest personnel provided technical support. Christine Waters assisted with typing. Wyoming Game and Fish Department provided funding.

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Received 5 December 1996; accepted 26 July 1997